

# Firefighting and Chemistry

“Fire fighting today is a science”

Chemistry is one of sciences that fire fighters need to be familiar with today. It is the study of matter. “Matter” is anything that has mass and occupies space – this includes all solids, liquids and gases.

Chemistry looks at:

- What substances are made of (composition and structure)
- How substances react with each other (behaviour and properties).

## Why is this important to fire fighters?

Fire (or combustion) is a chemical reaction. Knowledge of how substances react will help you understand:

- flammability,
- support of combustion,
- extinguishing properties.

Other properties of interest to fire fighters are:

- reaction with water,
- miscibility with water and density,
- acidity/alkalinity,
- toxicity and corrosiveness,
- radioactivity.

Many industries are chemical based. They use a tremendous variety of materials to produce substances such as petrol’s and other fuels, steel, cement, medicines, fertilisers, plastics, dyes, paints, ceramics, composites etc.,

## Composition of Matter

All matter is made up of atoms.

These are extremely small particles, which are invisible to the naked eye. It is very hard to imagine just how small they are. Consider this:

- 20 million atoms would fit on a 1cm line.
- The size of an atom: size of a golf ball is the same as the size of a golf ball: size of the earth.
- One atom of hydrogen has a mass of  $1 \times 10^{-23}$  grams.
- Atoms are the smallest particles that take part in a chemical change.
- There are about 103 different types of atom and each of these is known as an element.

## Elements

An element contains one type of atom only, which means it cannot be broken down into any simpler substance by chemical means.

### Table of Common Elements

Element	Symbol	Element	Symbol	Element	Symbol
Aluminium	Al	Fluorine	F	Nitrogen	N
Argon	Ar	Gold	Au	Oxygen	O
Barium	Ba	Helium	He	Phosphorus	P
Beryllium	Be	Hydrogen	H	Potassium	K
Boron	B	Iodine	I	Silicon	Si
Bromine	Br	Iron	Fe	Silver	Ag
Cadmium	Cd	Lead	Pb	Sodium	Na
Calcium	Ca	Lithium	Li	Tin	Sn
Carbon	C	Magnesium	Mg	Titanium	Ti
Chlorine	Cl	Manganese	Mn	Uranium	U
Chromium	Cr	Mercury	Hg		
Cobalt	Co	Neon	Ne		
Copper	Cu	Nickel	Ni		

## Compounds

A compound is formed when two or more elements (atoms of a different sort) are chemically combined, for example water, sodium chloride, and carbon dioxide.

- The atoms that make up a compound are always combined in the same proportions (by mass).
- The properties of compounds are not the same as the elements they are made of, for example: magnesium is a metal, oxygen is a gas, but magnesium oxide is a white powder.
- The constituents can only be separated by chemical means.

Elements and compounds are pure substances.

- They can only be changed by chemical reaction.
- Their melting points and boiling points are constant (under given conditions).

**The word molecule is used to describe the smallest portion of a substance (element or compound) which can exist by itself and still retain the properties of that substance.**

For example a molecule of water is made up of two hydrogen atoms and one oxygen atom; a molecule of chlorine is made up of two chlorine atoms, and a molecule of helium has only one atom.

A formula can be written which gives the number and types of atoms in a molecule of a substance.

Substance	Formula
Water	H <sub>2</sub> O
Chlorine	Cl <sub>2</sub>
Methane	CH <sub>4</sub>
Ethane	C <sub>2</sub> H <sub>6</sub>
Helium	He
Copper	Cu

## Mixtures

Mixtures are made up of more than one element and/or compound, in any proportion and mixed together.

- The melting points and boiling points of mixtures will vary.
- Mixtures can be separated by physical means e.g. evaporation, filtering.
- Mixtures usually keep the properties of the substances they are made from.

Examples of mixtures: air, alloys, salt water, composites, petrol, kerosene etc.

All matter can be put into one of these three types of substance.

